Virtual Science & Engineering Simulation

An Integrating Tool for Complex Decisions

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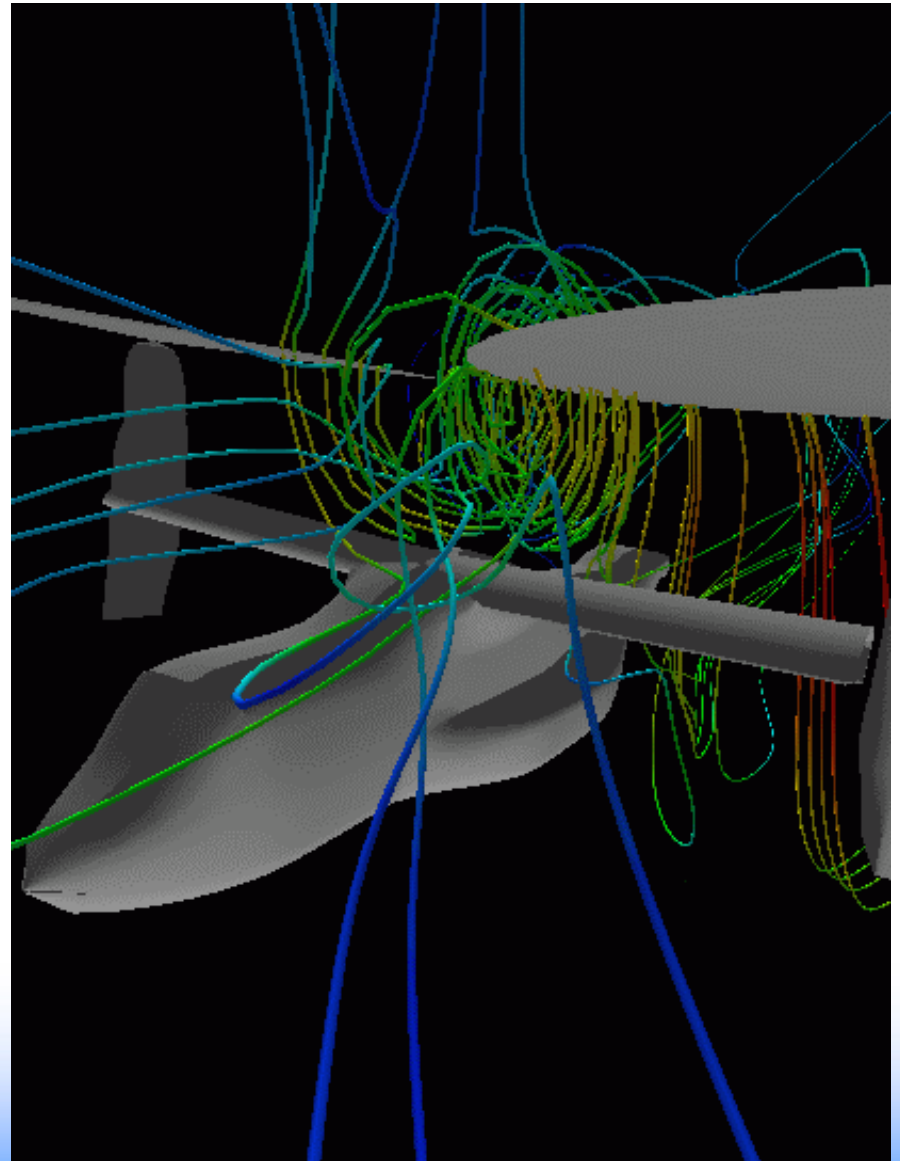
Virtual Science & Engineering (VS&E)

Interactive, user-centered, three-dimensional computer generated science & engineering environments that seamlessly allow the user to perform a wide range of science & engineering tasks.

- Design
- Analysis
- Optimization
- Operations
- Maintenance
- Training
- Economics
- Safety…

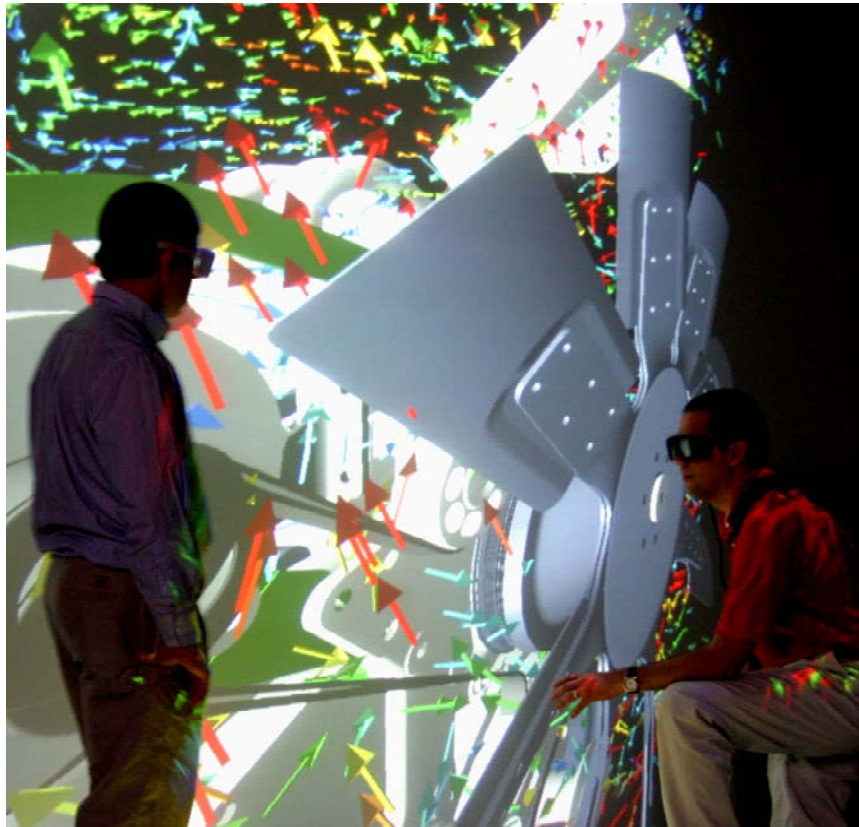Idaho National Laboratory

What do virtual reality tools do for us?

They change our vision of traditional engineering and allow us to build new paradigms for the future of engineering.

The Future of Virtual Science & Engineering

The goal

is

science &
engineering

not

visualization

High-level decision tools for and uncertain systems

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Engineering Decision Making

- Engineering decision making is an art based on both hard data (the numbers) and soft data (how does it feel based on experience)

- Modeling (e.g. CFD) and data can provide both but

  - Needs to be placed in context

  - Needs to enable interactive exploration

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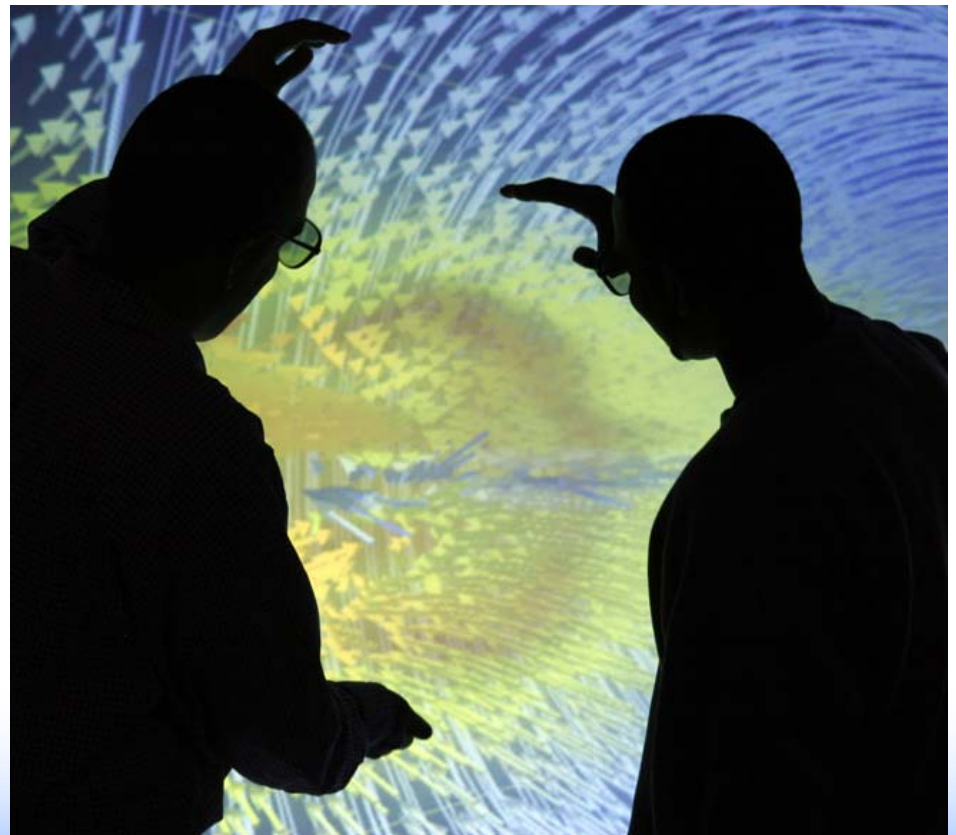
What is Needed?

- Visualization/interaction technology

- Real-time analysis/design

- Multi-system analysis and optimization

- Coupling, integration, and management of various engineering analysis codes
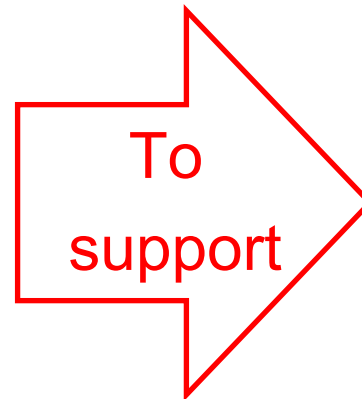
To support →

- Design
- Analysis
- Optimization
- Operations
- Maintenance
- Training
- Economics
- Safety….

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Examples of Current VS&E Work

- Bioenergy Program
  - Selective Harvest
  - Value Add Preprocessing

- LDRD Development
  - Advanced decision making tools
  - Synthetic fuels pathway integration

- Other Program Ties
  - SINEMA integration with VE-Suite integration framework
  - Yucca Mountain training simulation tools **(on hold)**

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Selective Harvest Model Integration

Seamless Integration of:

- Computational Fluid Dynamics Models (CFD)

- Particle Image Velocimetry (PIV)

- Interactive Design Canvas

- Successful Real-World Application (patent application filed)

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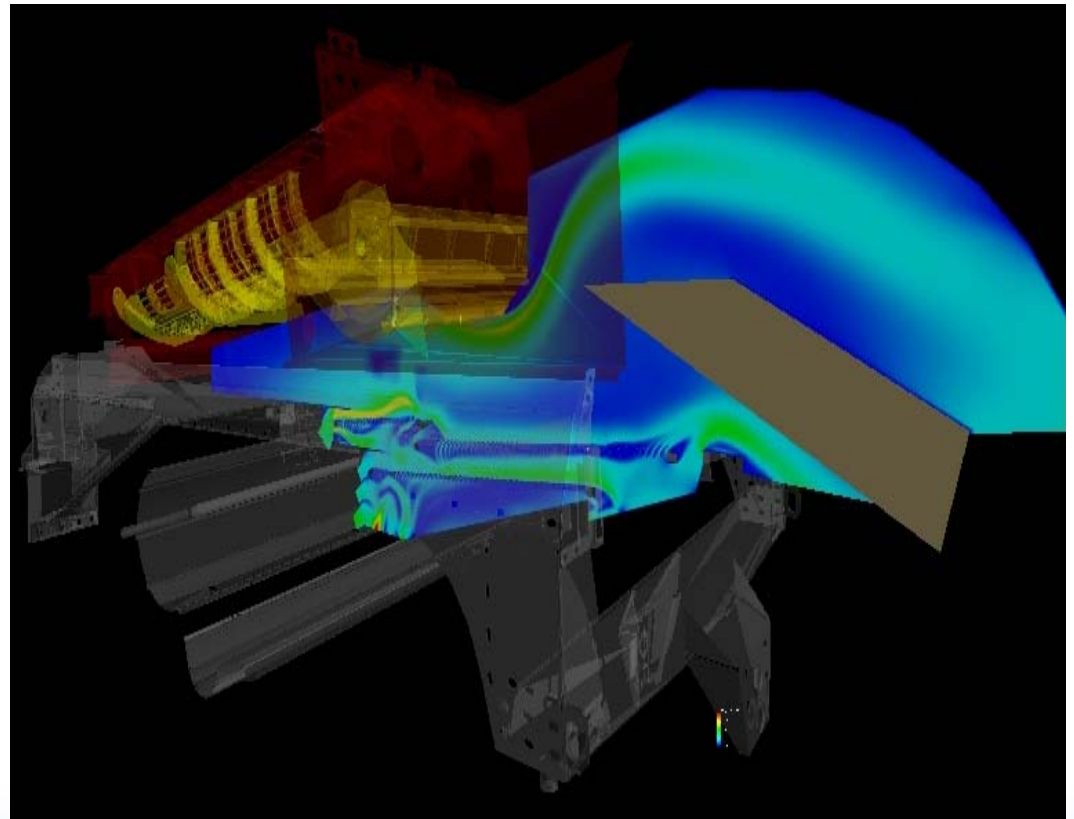
Preprocessing & Biorefinery Integration

Value Added Biomass Preprocessing for Bioenergy

Centralized facility for preprocessing biomass (Depot modeling)

- EXTEND feedstock assembly system model (production, harvest & collection, storage, transportation)

- ASPEN biorefinery conversion model (pretreatment, hydrolysis, fermentation, separation)


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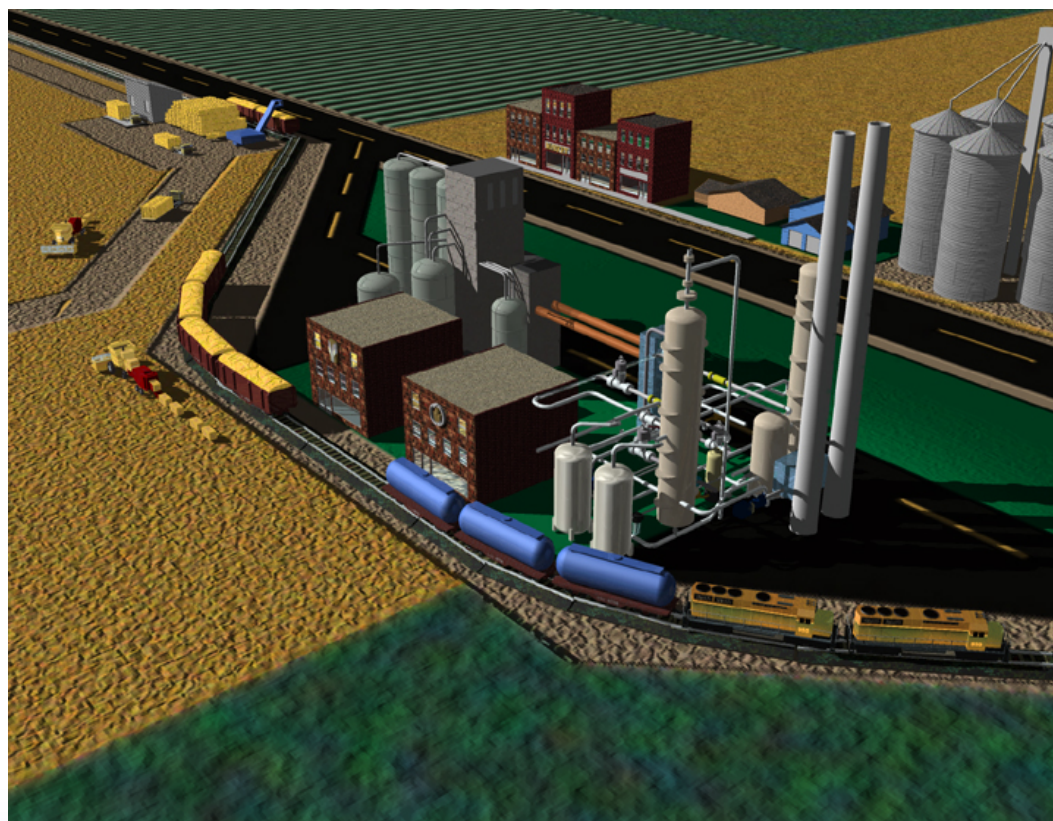
Advanced Decision Making Tools

Inverse Convection Problems

- Develop reduced order fluid models using Proper Orthogonal Decomposition (POD)

- Optimize POD using evolutionary algorithms (EAs)

- Speed up the solution using Quantitative Trait Loci (QTL) methods

Run A   Run B   Run D   Run E

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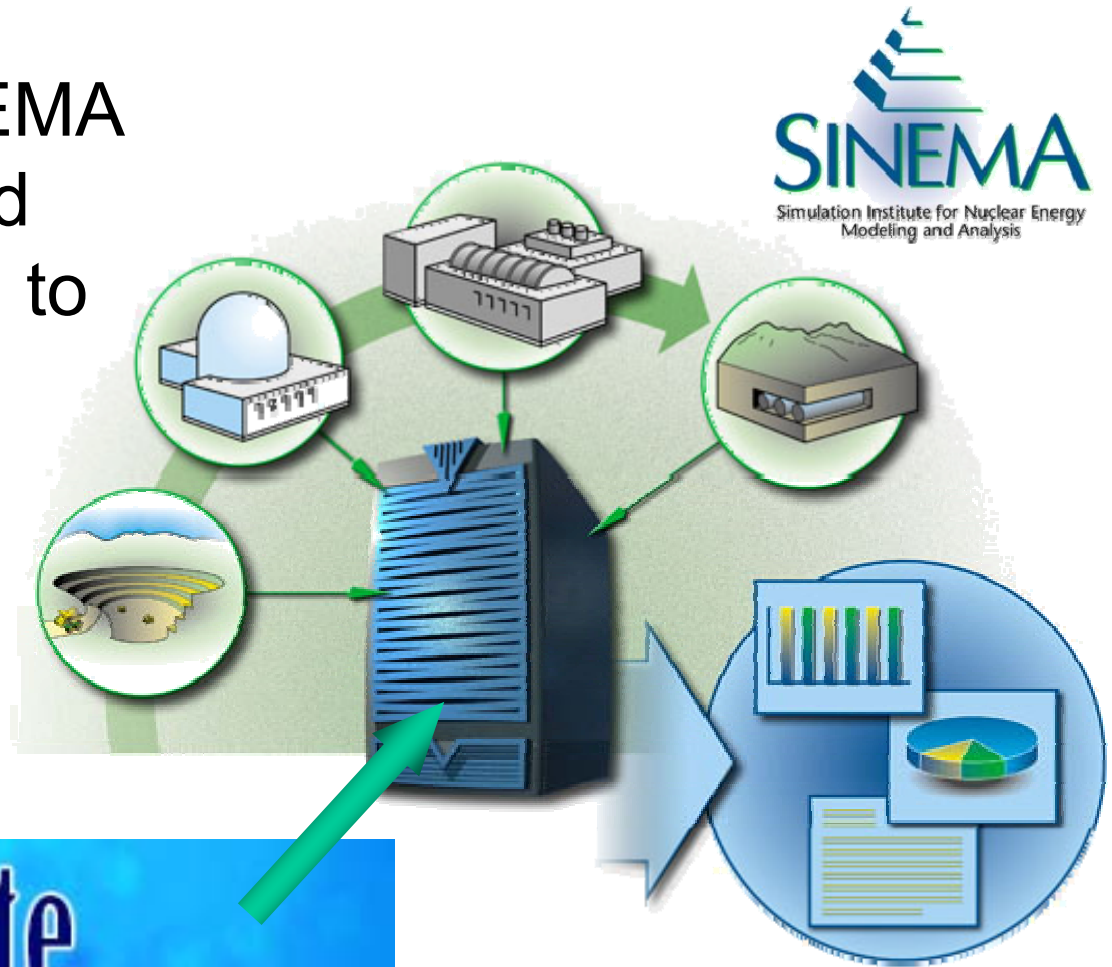PIV data

Combine
Flow Domain
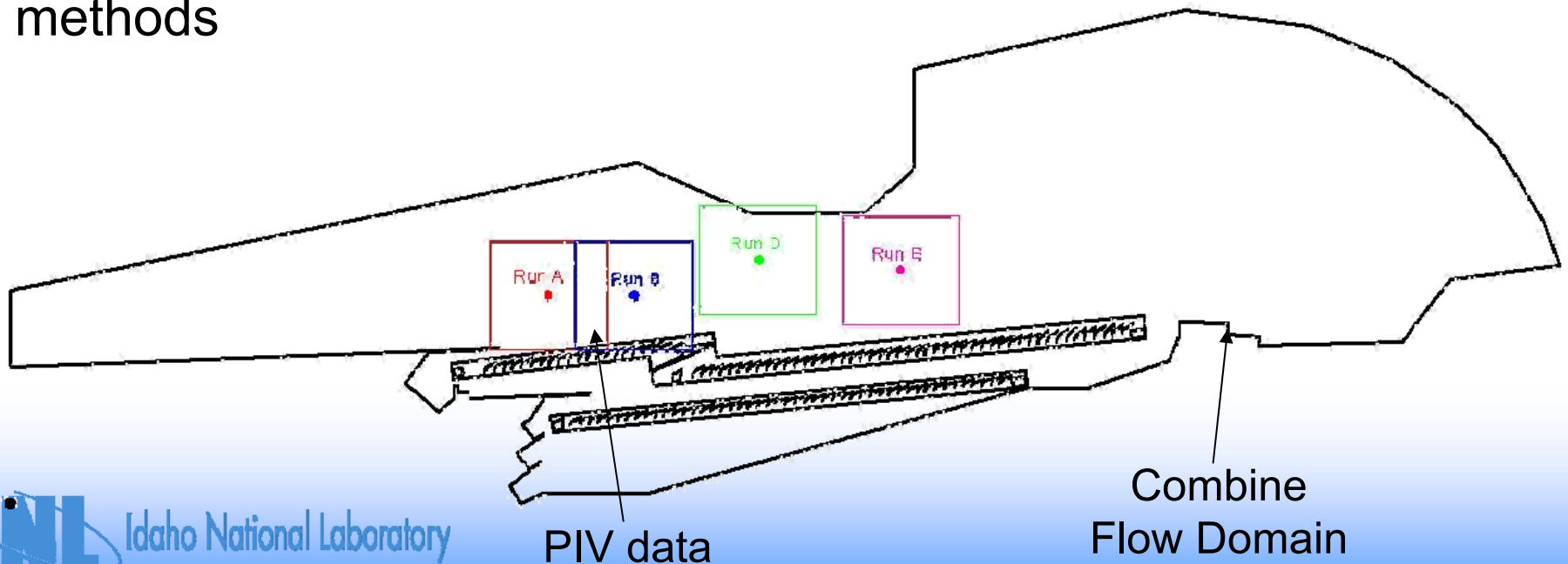
Synthetic Fuels Pathway Integration
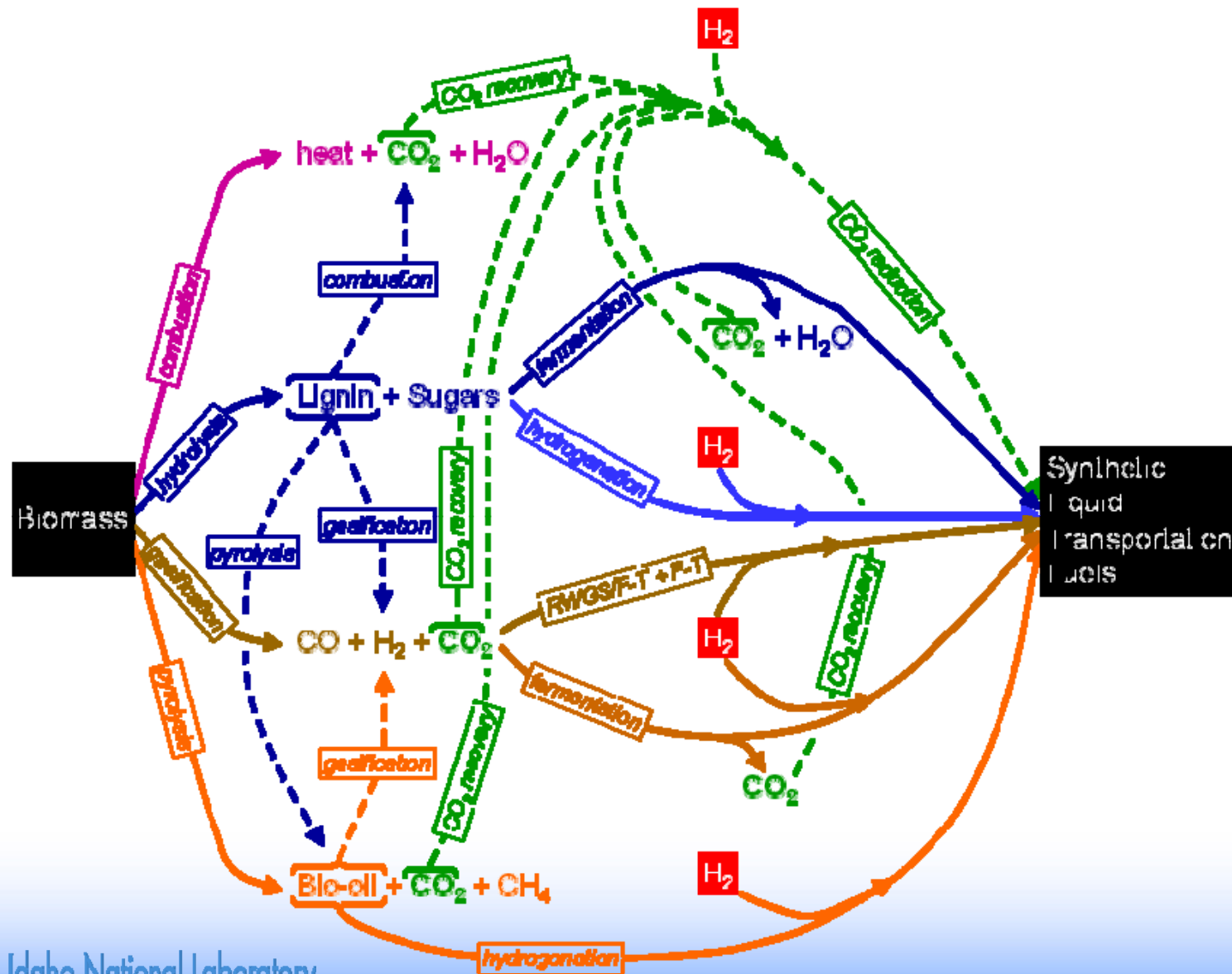
SINEMA Collaboration

- Initial ties with SINEMA was established and VE-Suite's potential to be the integrating framework was identified.

Virtual Science & Engineering Potential

- VS&E tools being developed and applied at the INL can be a cross-cutting, program integrating, and world-class establishing capability

- Many capabilities exist and many need to be developed

- New capabilities can be tailored to specific needs in an open framework

- Bioenergy Program will be supporting a full-time, on-site, Ph.D candidate to build these tools and support the vision.

INL Strategy Map

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